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AUTHOR Dodd, Jennifer; Elliott, H. G.
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ABSTRACT

This paper describes the results of a student science assessment test and teacher questionnaire surveying 424 sixth grade teachers in the province of Newfoundland and Labrador. The student test measures student attitudes to science and scientists, knowledge in life, physical and earth science, and student competence on 12 science processes appropriate for sixth graders. The teacher questionnaire measures perceptions of students' interest in science, reactions to content and process items, teacher use of science programs, and teacher data. Preliminary analyses of the questionnaire indicated that most teachers had a positive attitude to science, felt adequately prepared to teach the program, and thought the test appropriate but that it did not discriminate accurately between content and process task items. Recommended actions, a frequency distribution of the test scores, and sample test items are provided. (Author/YP)

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# ELEMENTARY TEACHER ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING AS THEY RELATE TO STUDENT TEST PERFORMANCE IN SCIENCE CONTENT AND PROCESS SKILLS

Jennifer Dodd
Memorial University of Newfoundland

and

H.G. Elliott
Department of Education
Newfoundland and Labrador

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Paper presented at the National Convention of the National Science Teachers Association, St. Louis, Missouri
April 8, 1988

Abstract:

A study conducted by the Science Council of Canada (1984) maintained that 18.6 percent of all elementary teachers in Canada would avoid teaching science if they had a choice. Harms and Yager (1981) reported that in the United States elementary teachers do not value and are not prepared adequately to teach exemplary science programs.

The Ministry of Education in Newfoundland and Labrador decided to examine grade six outcomes of the prescribed elementary science program in a comprehensive criterion-referenced science test. A committee of experienced science educators developed a bank of test items to measure 1) student attitudes to science and scientists, 2) knowledge in Life, Physical, and Earth Science, and 3) student competence on 12 science processes. These items were rigorously examined, field tested and the results analyzed before a final test was prepared.

Concurrently, Memorial University science educators developed a questionnaire to investigate teacher attitude to science, personal preparation for teaching science, and perceptions of the science test.

The test was completed by approximately 12,000 students and the questionnaire by 500 teachers. Analysis of the test results is currently underway. Preliminary analysis of the questionnaires indicates most teachers have a positive attitude to science, feel adequately prepared to teach the program and think the test appropriate but cannot discriminate accurately between content and process tests items. Sample test items are included.

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# ELEMENTARY TEACHER ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING AS THEY RELATE TO STUDENT TEST PERFORMANCE IN SCIENCE CONTENT AND PROCESS SKILLS.

DR. JENNIFER DODD
MEMORIAL UNIVERSITY OF NEWFOUNDLAND

H.G. ELLIOTT
Department of Education
Newfoundland and Labrador

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## THE STUDENT SCIENCE ASSESSMENT TEST

Purpose of the test.

A criterion-referenced test was developed and administered in June 1987 to determine the present status of elementary science in the schools and to enable teachers, school districts, and Department of Education personnel to make future decisions affecting science instruction in Newfoundland and Labrador.

Structure of the test.

Part I was a fourteen item inventory designed to measure student attitudes towards school-related science activities, interest in science and general attitudes toward science.

Part II was made up of fifty items focussing on the science content presented in the school science program and scientific process skills developed in grades 4, 5 and 6.

Development of the test.

A small committee of science educators and teachers developed test items, assembled two pilot tests which were administered to representative schools in the province, analyzed the results and developed a final test for administration to all grade 6 students.

Three major types of items were included measuring student attitudes to science, content knowledge and process skills. All items were presented in multiple choice format.

Test results.

10,056 students wrote the test. Detailed analysis of the results was carried out. The scores showed almost normal distribution with a slight negative skew (-.19). Attitude item analysis showed weak positive correlations with student achievement. Student achievement on the total test was 56.6% (S.D. = 14).

## THE TEACHER QUESTIONNAIRE

Purpose of the questionnaire

The questionnaire for grade 6 science teachers was designed to provide opportunity for the teachers to react to the first science test administered to elementary science students across the province since the adoption of a specific science program by all schools.

The questionnaire also sought information about the teachers themselves; their training, years in the classroom and in particular their attitude towards science, the science program and its implementation in the schools.

Structure of the questionnaire

The questionnaire was organized in four sections:

A. Perceptions of students' interest in science.
B. Reactions to content and process items.
C. Teacher use of the program.
D. Teacher data.

Multiple choice and open-ended questions were included in all sections.

Findings of the questionnaire

Teacher data This population of 424 grade 6 teachers was relatively mature, 75% having taught for more than 10 years and 28% for more than 20 years.

Half the teachers had done 2 first-year university science course planned for elementary teachers and the required course in teaching methods. 78% of the teachers had attended workshops on the science program. Seventy-five percent thought they had a good enough science background to teach the program and felt comfortable teaching grade 6 science. Many (57%) said they would not have changed their reaching if they had known more about the test in advance.

Reaction to the student test.

(i) Student attitudes to science. Most teachers (83%) agreed this section was very appropriate while a few (12%) mentioned some items they thought should not have been included. Most reported their students were very interested in science.

(ii) Content items. Twenty-four items were designed to measure facts or concepts the students had learned. Ten of these items measured knowledge by referring to activities which might have been done by the students.

Most teachers identified these items as measuring content their students had learned but almost the same number identified the items as measuring a process of science, especially when the items related to a science activity.

(iii) Process items. Twenty-six items were designed to measure six simple process skills and six complex process skills of science. These processes were evenly distributed in two other sub-sets of items, content-free process items and program-linked process items.

More teachers identified the program-linked process items as measuring both process and content their students had learned, but teachers again failed to discriminate as expected between content and processes measured in the test items.

The results suggest many teachers (58%) are merely discriminating items which test something their students have learned, and they are more likely to agree students have learned content presented in the program than process skills.

(iv) Suitability of items. Seventy-nine percent of the teachers agreed that the test items were suitable for grade 6 students. Slightly over half the teachers identified at least one specific item as being unsuitable with the most frequent explanation being that students found the topic difficult or missed the problem.

Teachers were more likely to agree that a test item is suitable for the students if it measures content than processes of science.

(v) Perceived facility and student achievement. There was no clear difference in the perceived facility of content and process items, but teachers did perceive program-linked items to be easier than content-free process items, and simple process items to be easier than complex process items. Several items were identified as difficult in an open-ended question also.

Correlations between perceived facility and student achievement showed that teachers were able to predict results most accurately for program-linked process items.

(vi) Other variables embedded in test items.

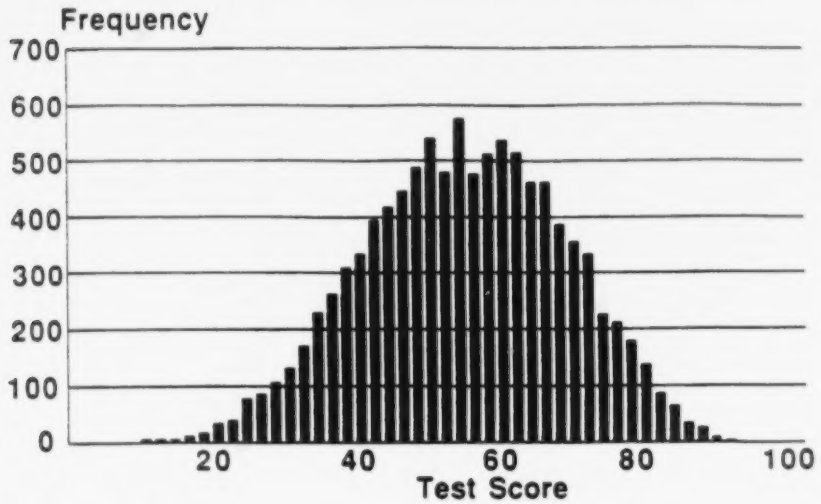
Other variables that may have influenced student achievement included the vocabulary used and the amount of reading in items, the inclusion of pictures or graphs, and the grade level on which an item was based.

## ACTIONS ARISING FROM THIS STUDY

A major report has been written and detailed summary results sent to all school boards.

Workshops are being presented to elementary teachers on the processes of science and their evaluation. A booklet, The evaluation of scientific processes, is being made available to all teachers. It is anticipated that another provincial science test will be implemented in 1990.

## Frequency Distribution of Test Scores




# TEACHER QUESTION

**Please circle the number which best indicates your response to each statement.**

Use the following code to circle your answers:
(Strongly Agree=SA; Agree=A; Neutral=N; Disagree=D; Strongly Disagree=SD)

| Item 45 | SA | A | N | D | SD |
|---|---|---|---|---|---|
| a) This item .s suitable for students after using the Addison-Wesley program in Grades 4, 5 and 6 | 1 | 2 | 3 | 4 | 5 |
| b) This item measures facts or concepts my students learned in their science program | 1 | 2 | 3 | 4 | 5 |
| c) This item measures a process of science that my students learned in their science program | 1 | 2 | 3 | 4 | 5 |
| d) Most of my students (60% or more) should be able to answer this item | 1 | 2 | 3 | 4 | 5 |

## Process

You want to find out which type of paper towel soaks up water the fastest.
You plan to dip one piece of each towel in a dish of water. What conditions must be kept the same in this experiment?

a) The size of the dish.
b) The colour of the paper towel.
c) The time the towels are in the water.
d) The amount of water in the dish.

## Content

Which pair of animals forms a link in the food chain?

a) Moose and Caribou
b) Gulls and Caribou
c) Seals and Codfish
d) Frogs and Beavers

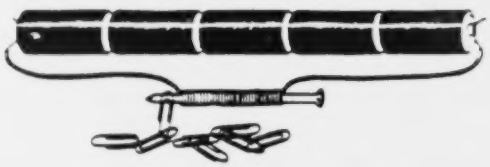
## Attitude

I like T.V. shows and magazine articles about science.

a) Yes
b) Not sure
c) No

## Process Item (Program Linked)

In experimenting with the effects of a number of batteries on the strength of an electromagnet, John discovered that when 5 batteries were placed in a circut, as shown below, he could pick up 8 paper clips.



Before making any statement on the number of paper clips picked up by five batteries forming an electromagnet, the best procedure John could follow is to:

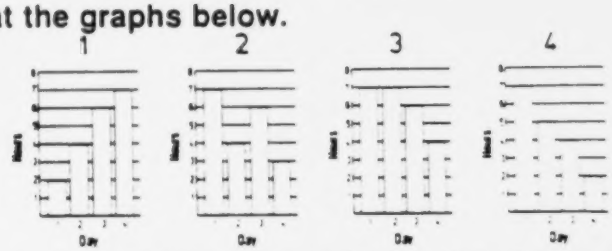
a) do one more test and average his results.
b) do several more tests and average all the results.
c) report his first finding.
d) report his last finding.

## Process Item (Content Free)

Homing pigeons are birds that can find their way home from long distances. A man released a pigeon 340 kilometers from home. He did this four days in a row and recorded how long it took the pigeon to return home. He got these results.

| Day | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Time | 7 hours | 5 hours | 4 hours | 2 hours |

Look at the graphs below.



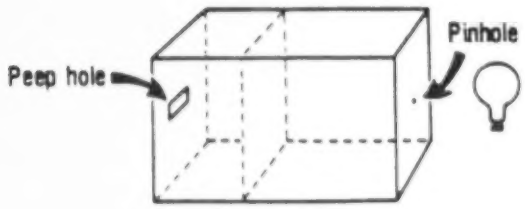

Which graph shows the results for the pigeons?
a) Graph 1, b) Graph 2, c) Graph 3, or d) Graph 4.

## Suitable Content Items

~ A Baby chick grows inside an egg for 21 days before it hatches. Where does the baby chick get its food before it hatches?

a) It is fed by the mother hen.
b) It doesn't need any food.
c) It makes its own food.
d) It uses food stored in the egg.

~ Jane enjoys using a pinhole camera. One day she observed a lighted bulb using a camera similar to that shown below.




The image which she observed would look like:

## Suitable Simple Process Item

Equal amounts of water were poured into the two containers shown below.

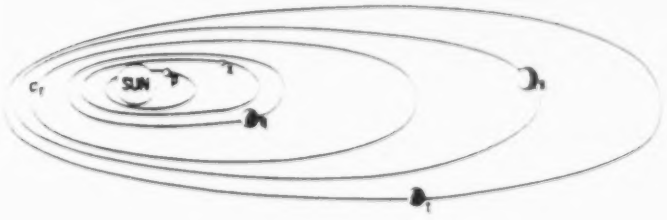
1 2

If both containers were placed in the sun for a period of two hours, we might expect to find:

a) less water in each container than in the beginning, but still equal amounts of water in container 1 and container 2.
b) more water in container 2 than 1.
c) more water in container 1 than 2.
d) the same amount of water in each container as there was in the beginning.

## Suitable Complex Process Item

This model represents the distances of some of the planets from the sun and shows their orbits.




Which planet has an orbit around the sun which is longer than planet x's orbit but shorter than planet's orbit?

a) Planet s, b) Planet q, c) Planet t, or d) Planet p.

## Content Items Perceived as Measuring Process Skills

Below are examples of chemical and physical changes. Which of the following is an example of a physical change?

a) Paper burning.
b) Iron rusting.
c) Glass breaking.
d) Apple rotting.

The gene for brown eyes is dominant over the gene for blue eyes. If Bob inherits one gene for brown eyes and one gene for blue eyes, he will have:

a) brown eyes.
b) blue eyes.
c) green eyes.
d) one blue eye and one brown eye.

## Test Item Clearly Identified as Content (facts or concepts learned)

Which group of animals are arthropods?

a) Carpenter, beetle, sea star.
b) Lobster, earthworm, crab.
c) Spider, beetle, crab.
d) Snail, seastar, spider.

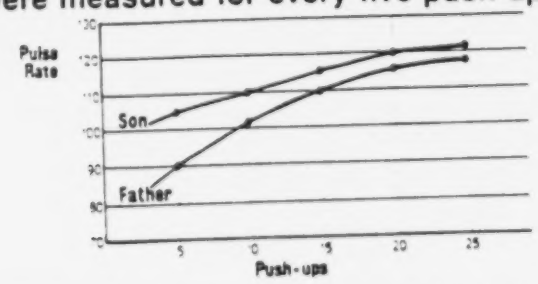
## Unsuitable Test Item

The operational (working) definition of the term weight is:

a) the distance a spring is pulled down when an object is hung on it.
b) how big an object is.
c) the pull of the earth's gravity on an object.
d) a unit of measurement used to balance an object on a scale.

## Item Teachers Rated Difficult

The graph below shows the change in pulse rate of a father and his son while they were doing 25 push-ups. Their pulse rates were measured for every five push-ups.




Which of the following statements is correct?

a) The son's pulse rate increased more than his father's pulse rate during the exercise.
b) The father's pulse rate increased more during the exercise than the son's pulse rate.
c) The son's pulse rate after 25 push-ups is twice his father's pulse rate.
d) The father and son have the same pulse rate at the end of the experiment.